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ADP013052

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ADP013002 thru ADP013146

8th Int. Symp. "Nanostructures: Physics and Technology"
St Petersburg, Russia, June 19–23, 2000

A giant shot of radiation intensity of space indirect exciton line in double quantum wells in GaAs/AlGaAs

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Investigation of properties of double quantum wells (DQW) attracts nowadays a great interest of scientists both from theoretical and experimental points of view. This interest is caused by existence of space indirect excitons (IX) in a DQW that are formed of an electron (e) and a hole (h) localized in different quantum wells of a DQW. Due to the fact that e and h in an IX are separated in real space this IX has a significantly larger radiative time than a direct exciton (DX) formed of an electron and a hole in the same quantum well. The latter fact allows us to obtain practically a gas of IX of rather large density even at small densities of excitation and, as a consequence, to expect different collective properties of a system of separated electron–hole pairs (excitons) of large density to display experimentally.

One of the interesting collective properties following from the Bose-gas statistics is a possibility of appearance in such a system of Bose–Einstein condensation (BEC) when a macroscopic number of particles occupies the lowest energetic state in the system. Though it is well known that no BEC exists for free bosons in exactly two dimensions, the situation drastically changes if in addition to the extended (free) states excitons can occupy descrete (localized) states, which are positioned lower in energy with respect to the extended states. Really, as it was shown theoretically [1], in this case chemical potential is not allowed to approach bottom of the boson free states and hence even at nonzero temperatures T there is a finite value of bosons n_c(T) which can be accomodated by the extended states. The existence of the upper limit $n_c(T)$ means that whenever actual boson density n exceeds this limit, the extra amount $n - n_c(T)$ will spill over to the localized states — the BEC effect.

We present systematic study of the IX luminescence line from the samples with GaAs/AlGaAs DQWs (detailed descriptions of sample and experimental setup are given elsewhere [2]) in the wide range of experimental parameters such as bath temperature, excitation power and value of the external electric field applied to the sample. At certain values of external parameters we detected the giant (up to three times) shot in luminescence intensity within some part of the IX spectral profile. We discuss the observed phenomenon in the frame of theoretical model [1] of BEC which in our case is determined by the existence of localized states formed by the heterointerface potential fluctuations. In this sense the occupation of localized states by the macroscopic number of excitons which takes place within the limited space regions restricted by the heterointerface potential fluctuations resembles an experimentally discovered phenomenon of BEC on alkali atoms in space-limited traps produced by the magnetic field (for a detailed review see [3]).

We are gratefully acknowledged to the Russian Foundation for Basic Research (98-18296) for the partial financial support.

References

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[3] F. Dalfolo, S. Giorgini, L. P. Pitaevskii and S. Stringari, *Rev. Mod. Phys.* **71**, 463 (1999).